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A Thorny Problem: Glyphosate and 2,4-D Associated with Neurobehavioral Effects for Ecuadorian Adolescents

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Ecuador is the world's third-largest exporter of cut flowers,[1] and many of those flowers originate in Pedro Moncayo, a county in the northern Andes.[2] The pesticides used by local farms to manage weeds, insects, and fungi may also affect residents in communities nearby. A new study in *Environmental Health Perspectives* found that exposures to two of the herbicides commonly used in Pedro Moncayo were associated with adverse neurobehavioral outcomes for local adolescents.[3]

This paper emerges from ESPINA (Estudio de la Exposición Secundaria a Plaguicidas en Niños y Adolescentes, or Secondary Exposures to Pesticides among Children and Adolescents),[5] a cohort study that began in 2008. Principal investigator José Ricardo Suarez-Lopez, an associate professor at the Herbert Wertheim School of Public Health and Human Longevity Science at the University of California, San Diego (UCSD), says his goal is to understand more about how pesticides may be affecting our bodies. "We tend to assume that the chemicals that are being sprayed have been tested and that we know of their long-term safety," he says. "And what we're understanding is that there's not enough science about the long-term [human] health effects of most commonly used pesticides."

In this study, the researchers analyzed data from 519 adolescents (11–17 years of age) in the community by analyzing spot urine samples for biomarkers of exposures to the herbicides glyphosate and 2,4-dichlorophenoxyacetic acid (2,4-D), and the insect repellent *N*,*N*-diethyl-meta-toluamide (DEET). Glyphosate is one of the most prevalent herbicides in the world and the active ingredient in Roundup™.[6] An older compound often used in lawn care, 2,4-D is becoming more popular for agricultural use as weeds have begun developing resistance to glyphosate. Sometimes the two weed killers are used together.[7] DEET is used in almost one-third of Ecuadorian homes as a mosquito repellent.[8]

Next, the team measured five domains of the participants' neurobehavioral performance: attention and inhibitory control, memory and learning, language, visuospatial processing, and social perception. Exposure to DEET was not associated with any of the neurobehavioral outcomes. However, 2,4-D and glyphosate were another story. "These herbicides were associated with alterations in all of the domains of neurobehavior, which really surprised us," says Suarez-Lopez. "I was not expecting to see such a robust association." Detected in 66.2% of the participants, 2,4-D was associated with negative impacts on all five domains. Glyphosate, detected in 98.3% of participants, was associated with lower performance on the social perception tests, which measure how well participants can identify the emotions or moods of others.

First author Briana Chronister, a doctoral candidate in a joint UCSD–San Diego State University program in public health,

The flower-growing industry employs about one-fifth of all adults left, in Pedro Moncayo County, right, and sprays more than 70 fungicides and pesticides according to the authors. The ESPINA study[4] is investigating secondary exposures of the county's children and adolescents. Images: © GDA/AP Images, left, and Courtesy of Natura Films (Quito, Ecuador), right.

says there was also evidence of interactions between the two herbicides. "Co-exposures to these herbicides might impact these domains more than either would individually," she says.

Ramon Velazquez, an assistant professor at Arizona State University's School of Life Sciences and Neurodegenerative Disease Research Center at the Biodesign Institute, says this study immediately piqued his interest in how early glyphosate exposure might interact with cognitive aging. Although the study looked at associations in younger people, Velazquez, who was not involved in the new research, thought its results could apply to his own work on neurodegenerative disease.[9] He says it is worrisome, but not surprising, to see high concentrations of glyphosate—the herbicide that he studies—measured in the ESPINA cohort. "If they're getting exposed to this [chemical] early in life," he says, "it's likely going to do something to their bodies," such as exacerbating other conditions, not just in youth but in later life, too.

Velazquez is especially concerned about the relationship between glyphosate and inflammation, which has been assessed in animal studies.[9] "Chronic inflammation . . . can interfere with neuronal and glial well-being, leading to dysregulation of brain homeostasis and compromising cognition," he says. More work is needed to understand the long-term consequences of glyphosate exposure, and this current work joins another recent study[4] showing that exposures early in life happen, and they are associated with harmful health outcomes.

The present study is one of the first to characterize an association between exposure to 2,4-D and glyphosate and impaired neurobehavioral performance among children and teens, according to the authors. But Suarez-Lopez and Chronister note that the ESPINA study is working to answer many questions that remain. For instance, the researchers still want to understand the geographic and occupational exposure sources for the local population and to evaluate short- and long-term health alterations from seasonal pesticide use. It is also important, they say, to understand effects of these pesticides on hormone disruption, mental health, inflammation, and other health systems. "Our study will allow us to evaluate the toxicity potential of these and other chemicals assessed from childhood through adulthood," says Suarez-Lopez, as his team follows the children into adulthood and evaluates the legacy of these exposures in their lives to come.

Jori Lewis writes about the environment, agriculture, and international development. She is the author of *Slaves for Peanuts: A Story of Conquest, Liberation, and a Crop That Changed History*.

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